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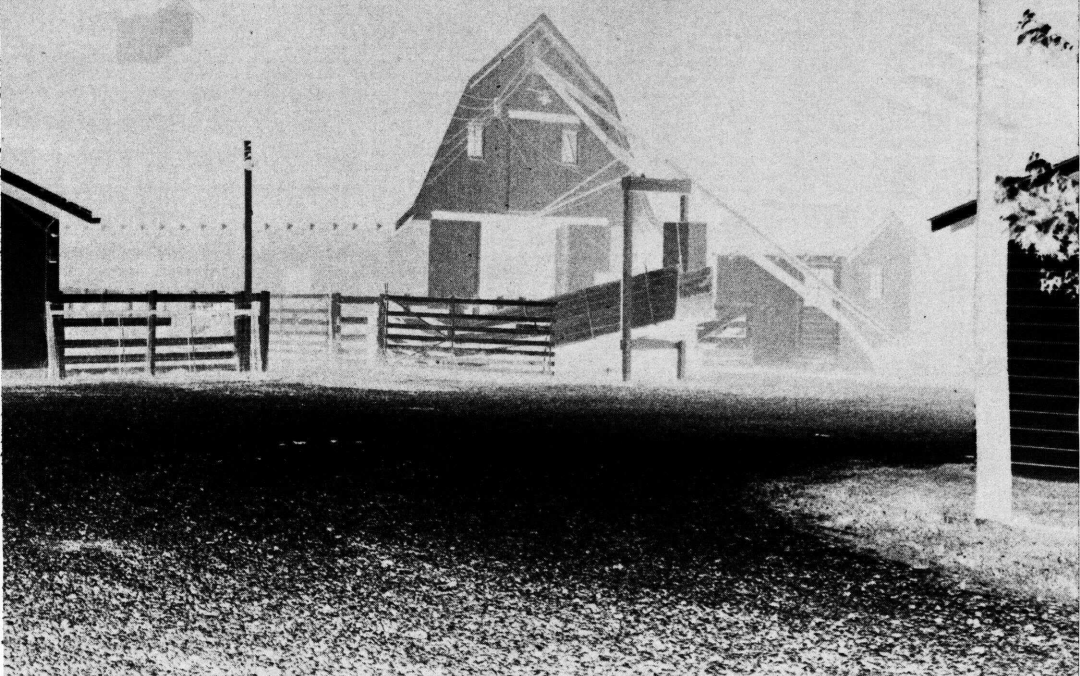
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FARM LIGHTING

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Some of the information in this publication is based upon recommendations and reports of the Illuminating Engineering Society and the American Society of Agricultural Engineers.

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FARM LIGHTING

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Lighting in and around farm buildings is needed for you to work easily, conveniently, and safely. Also, you need lighting for the production and protection of livestock and poultry.

Electric lighting is usually preferred for indoor work, but you can use daylight if windows are placed properly. To reduce glare, shield windows facing direct sunlight.

Lighting for the farm should be planned. This planning can be complex and technical, largely because there are so many alternative ways to get good farm lighting. This bulletin gives some recommendations and suggestions for planning farm lighting. You will need additional help in many situations.

You can obtain help from power suppliers, State agricultural extension services, and lighting engineers and architects. Lighting demonstrations or visits to well-lighted farms may also be helpful.

The detailed applications of farm lighting are discussed later in this bulletin. But before they can be discussed, the characteristics of

light and the equipment used in lighting need to be reviewed.

CHARACTERISTICS OF LIGHT

Good lighting is a combination of quantity, quality, and color of light. The quantity, measured in foot-candles, should be enough to make the object being observed clearly visible. The foot-candles recommended in this bulletin are based on established requirements for optimum performance of specific and general work, except for the lighting guide for poultry production. Other levels of illumination may be desirable according to individual requirements or preferences.

Quality of lighting depends on freedom from glare, control of shadows, and the absence of sharp differences between lighted objects and the background. Glare is brightness that causes discomfort; it may be direct or reflected.

Direct glare can be reduced if you shade the light source from view, or place the source well above the normal line of sight. Reflected

glare can be reduced if you paint the walls and ceilings with a flat finish. For good lighting, install properly placed fixtures that have diffusion louvers and suitable brightness.

When the difference in brightness between objects or between objects and background is too great, the difference is annoying. A work area should be no more than five times as bright as adjacent dark surroundings, and surroundings should be no more than five times as bright as the work area.

Standard electric lamp sources differ in color from natural daylight. Incandescent lamps appear slightly yellow, fluorescent lamps are slightly blue, and clear mercury lamps appear greenish to blue-white unless color-corrected lamps are used. Special-color lamps are used for grading agricultural products where the color of light is important.

LIGHTING EQUIPMENT

Incandescent lamps

Electric lamps require lighting fixtures or lampholders. Most incandescent lamps used for general lighting usually need reflectors. These reflectors reduce glare and increase light output in the desired direction.

Some incandescent lamps have reflectors built into the lamps. Reflector lamps made of special glass are used outdoors in weatherproof fixtures.

Incandescent fixtures have a maximum wattage stamped on the fix-

The total amount of light emitted from a lamp or fixture is measured in lumens. The amount of light on a surface is measured in foot-candles.

ture. Increasing the wattage of lamps in these fixtures may cause high temperatures, fire hazards, and reduced lamp life.

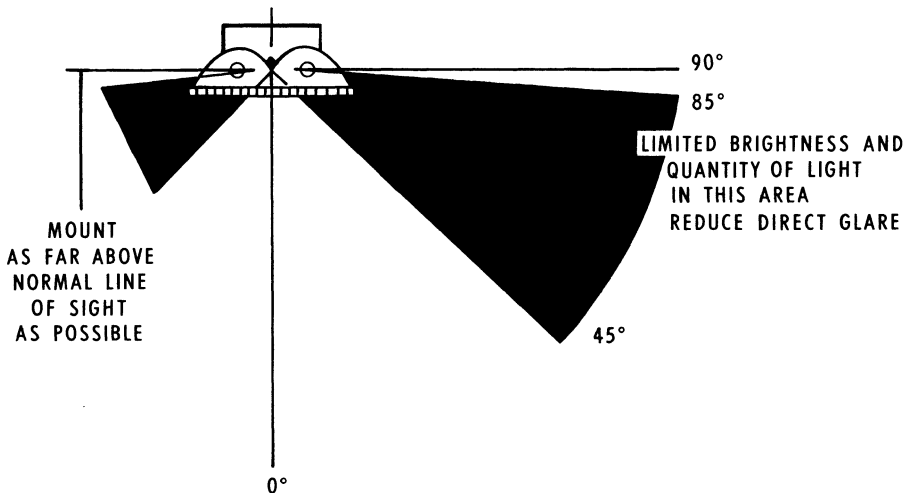
Incandescent lamps are available in a wide range of sizes, types, and shapes. The most common shapes are available in sizes up to 300 watts.

Lamps up to 300 watts have standard screw bases that can be used in ordinary medium base sockets. Nearly all incandescent lamps have a white or frosted finish that diffuses the light and reduces glare.

Incandescent lamps are generally selected when light is needed for short periods of time and when lamps are turned on and off frequently.

Standard incandescent lamps have an average rated life of 750 to 1,000 hours before burnout. Longer life (extended service) lamps last 2,500 hours; but the light output is less by 10 to 15 percent and the initial cost is greater.

Rough-service incandescent lamps are similar to standard lamps except that they are designed to resist shock. Light output is 15 to 20 percent less than standard incandescents. Rough-service lamps are useful as portable extension lamps. They are identified by the words "rough service" etched on the end of the lamp opposite the base.



Louvers in fixtures keep the angle of direct light to about 45 degrees.

Another type of incandescent lamp is tungsten halogen. This is a gas-filled tungsten lamp with iodine or other halogens that improve operating characteristics.

Tungsten halogen lamps for general lighting have a rated life of 2,000 to 3,000 hours. Reflector-type tungsten halogen lamps are rated at 2,000 hours.

The light output of standard incandescent lamps decreases over the life of the lamps about 20 percent of the initial lumens. Tungsten halogen lamps decrease only 10 percent.

Fluorescent lamps

Fluorescent lamps are used mainly indoors. The fixture includes a ballast and starter circuit. Fixtures can be used with one size (wattage) lamp only.

Lampholders on channel boxes enclosing the ballast, starting circuits, and wiring are known as strip

fixtures. Fixtures with a ballast and reflector are called direct or industrial fixtures.

Better brightness control and efficiency of light output are obtained when egg-crate-type metal or plastic louvers are a part of the fluorescent fixture. These louvers keep the angle of direct light to not more than a specified angle, usually about 45 degrees. Other transparent covers can be used to diffuse the light.

Louvered fixtures permit free circulation of air. They tend to keep cleaner than enclosed fixtures except for waterproof types. Where water from cleaning is likely to be splashed on the lamps, waterproof fixtures are recommended.

The rated life of fluorescent lamps ranges from 7,500 to 15,000 hours, depending on the size and type of lamp and the fixture. Light output decreases to two-thirds of the initial lumens by the end of rated life.

Fluorescent lamps should be replaced when light output is below two-thirds of initial light output.

The rated life of fluorescent lamps is based on 3 hours of operation for each time the lamp is turned on. Shorter operating times per start will decrease rated life, and longer operating times will increase rated life.

Life and light output ratings depend on the use of standard fixtures and ballasts. Fixtures or ballasts that differ from the standards may decrease lamp life and light output. Rapid-start fixtures (30 watts and up) generally show 25 to 50 percent improvement in usable tube life when compared to preheat-start fixtures.

Most fluorescent lamps are marked for use with both preheat-start and rapid-start fixtures. Some are designed for only one type. If you choose lamps marked for both types, you will prevent difficulties in lamp operations. The information is etched on the glass at the end of the tube near the manufacturer's label. For 40-watt and larger lamps, rapid-start fixtures are recommended.

Fluorescent lamps are most common in cool white, warm white, white, and daylight colors. Different colored lamps of the same wattage are interchangeable in fixtures.

Mercury lamps

Mercury lamps combine the small size of incandescent lamps with the long life and high efficiency of fluorescent lamps. Like fluorescents,

Caution.—Mercury and incandescent lamps with similar bases are not interchangeable except for mercury lamps with built-in ballast. Both incandescent and mercury lamps are likely to be damaged or destroyed when connected to improper circuits.

mercury lamps require ballasts to regulate the flow of current. Mercury lamps are available with partial color correction for use where the greenish color is objectionable.

High-pressure sodium lamps are mercury-type lamps similar in operation to standard mercury lamps. Mercury and high-pressure sodium lamps are highly efficient and have an average life of up to 16,000 hours.

Most mercury and high-pressure sodium lamps operate in fixtures with special ballasts. A few types of mercury lamps have ballasts built in the lamps. They can be operated from regular incandescent holders. These lamps are less efficient than separate ballast types.

Mercury and similar lamps are suitable for high-intensity lighting where the fixtures can be mounted 20 or more feet above the area to be lighted. For all-night outside lighting, a photoelectric unit can be used to turn the lamps on at dusk and off at dawn.

A great variety of mercury and similar lamps are available. Each lamp requires a special ballast, although similar reflectors or fixtures will shield these bright lamps from direct view and increase the directional control of light.

PLANNING GOOD LIGHTING

Begin planning good lighting for the farm by evaluating areas and activities where light is needed. Next, determine the foot-candle level needed for each area or activity. Then select suitable lighting equipment and have it installed properly for good light distribution.

Lamp requirements for lighting most work areas can be computed on the basis of fixtures mounted 7 to 10 feet above the floor. For higher mountings, the total lumens needed to light an area must be increased. The finish of the walls and ceiling should have medium to average reflectance.

Under these conditions, 2 lumens of output per lamp for each square foot of floor area provide an average light level of about 1 foot-candle per square foot at the working level. This ratio accounts for the efficiency of the entire lighting system, including lamp output, use of reflectors, reflectance of walls, and other factors.

Normally, the lamp fixtures will be installed in rows the length of the area. The lamps should be arranged so they provide nearly uniform lighting. When no more than 5 to 10 foot-candles of light are needed, the distance between lamps should be about 1 to $1\frac{1}{2}$ times the distance from the lamps to the floor.

When more foot-candles are needed, the spacing between lamps can be reduced to less than one times the distance to the floor so enough lamps can be used to give the required light. The distance from the

outside lamps to the walls should be no more than one-half the distance between lamps.

When the spacing between lamps is $1\frac{1}{2}$ times the distance to the floor, use shallow dome reflectors. If the spacing is one times the distance to the floor, or less, install standard dome or deep bowl reflectors.

The following example shows how you can determine the number of fixtures and the size of lamps that should be used in most work or storage areas.

Suppose you need 5 foot-candles of light in a machinery storage area 24 feet wide and 48 feet long with the lamps installed 10 feet above the floor.

The fixtures should be 10 to 15 feet apart. If a row of fixtures is installed 6 feet from each long wall, 12 feet remain between the two rows. This provides an acceptable spacing across the 24-foot width of the area.

Next, determine the number of fixtures needed in each row. Since the area is 48 feet long, and the spacing between rows is 12 feet, four fixtures per row spaced 12 feet apart will give the proper spacing. The fixtures at the ends of the rows will be 6 feet from the walls. This gives two rows of four fixtures each in the area, a total of eight fixtures.

Next, you determine the size of lamps required for each fixture. You know the floor space equals 1,152 square feet and that 2 lumens of lamp output per square foot are needed to obtain a light level of 1 foot-candle per square foot.

Multiply 1,152 by 2 and you find that 2,304 lumens are required to obtain a light level of 1 foot-candle. The work area needs a light level of 5 foot-candles. Multiply 2,304 lumens by 5 and you get 11,520 lumens, the number you need for a light level of 5 foot-candles.

To find the lamp size, divide the number of fixtures into the total lumens. This gives the lumens required per lamp. Select the correct size lamp from the list below. When the lumens per lamp fall between lamp ratings, use the next larger size or recalculate using other lamp spacings.

In this example, divide 11,520 lumens by 8 lamps. This gives 1,440 lumens per lamp. From the list of lamps, you find that 100-watt incandescent lamps or 40-watt fluorescents will give the required lumens for 5 foot-candles at floor level.

In areas with dark walls and a dark ceiling, or areas with no ceiling, you will need to increase the size of the lamps. Check light levels with a light meter.

You can use this example to guide you in computing the lighting requirements for any of the areas discussed in this bulletin except outdoor lighting. In the section on outdoor lighting, specific sizes and types of lamps are recommended.

Average Lumens Per Lamp

Incandescent, standard

<i>Watts</i>	<i>Lumens</i>
15	125
25	225
40	430

Incandescent, standard—Cont.

<i>Watts</i>	<i>Lumens</i>
60	810
100	1,600
150	2,500
200	3,500
300	5,490

Incandescent, tungsten halogen

<i>Watts</i>	<i>Lumens</i>
400	7,000 to 7,500
500	9,000 to 10,000
1000	20,000 to 21,000
1500	30,000 to 33,000

Fluorescent

<i>Watts</i>	<i>Length</i>	<i>Lumens</i>
15	18 in.	500 to 700
20	24 in.	800 to 1,000
40	48 in.	2,000 to 2,500
60	48 in.	3,000 to 3,500
110	96 in.	5,000 to 6,000
210	96 in.	10,000 to 12,000

Mercury

<i>Watts</i>	<i>Lumens</i>
75 to 85	2,000
100	2,500 to 3,000
175	5,500 to 6,500
250	9,000 to 10,000
275 (high-pressure sodium-type)	25,000
400	17,000 to 19,000
400 (high-pressure sodium-type)	40,000

POULTRY LIGHTING

Light is required in poultry houses for egg and meat production and so workmen can see. One or two foot-candles for more than half of each day are required to stimulate production. Twenty foot-candles are recommended when work is being done. You may find it convenient to have two lighting systems—one for egg and meat production and another for working in the poultry house.

For complete information on lighting to stimulate production, see Farmers' Bulletin 2229, "Lighting Poultry Houses."¹

You can use the chart on this page as a general guide for lighting poultry and poultry houses.

DAIRY LIGHTING

Both incandescent and fluorescent lights are used in dairy barns, milking parlors, and milk rooms. Fluorescent lamps may be used for general lighting, and incandescent spots or floods may be used for concentrated light in specific areas. In a dairy barn, locate lamps on the ceiling, both behind and in front of the cows.

Use the chart on page 10 as a guide for lighting dairy buildings.

¹ For a free copy, ask your county agricultural agent or write to the Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250. Send your request on a post card. Include your ZIP Code.

GENERAL INDOOR LIGHTING

Storage areas, stairs, alleyways, machine sheds, and similar buildings need a general lighting system for safety, convenience, and efficiency. Provide supplemental light as needed for specific tools or special locations.

Use the chart on page 11 as a guide for general indoor lighting.

OUTDOOR LIGHTING

Outdoor lighting enables work to be completed more quickly, easily, and safely after dark; it helps protect buildings, machinery, and livestock from prowlers; and it reduces the likelihood of accidents.

Weatherproof wiring and fixtures are used in outdoor lighting. Reflector-type incandescent lamps are used for lighting small areas and areas where lamps are used occasionally or for short periods of time. Mercury lamps, other similar lamps, and fluorescent lamps are used where light is needed for long periods of time.

Lighting Guide for Poultry Production

Type of poultry	Age (weeks)	Minimum foot-candles
Chickens:		
Broilers.....	0 to 3.....	1.0
Broilers.....	3 and up.....	0.5
Pullets, layers, and breeders.....	0 and up.....	1.0
Turkeys:		
Market stock.....	0 to 5.....	2.0
Broilers.....	5 and up.....	0.5
Breeder hens and breeder toms.....	0 and up.....	2.0



BN-33727

Cleanliness and good working conditions call for well placed lighting in dairy buildings. Here vapor-proof incandescent units provide a wide distribution of light fully utilized by the high reflectance of ceiling and walls.

Lighting Guide for Dairy Buildings and Equipment

Area or activity	Recommended foot-candles	Typical installation
Feeding area.....	20	Incandescent or fluorescent.
Milking area.....	20	Incandescent or fluorescent.
Cow's udder.....	50	Incandescent spot or high intensity fluorescent in milking parlors; fluorescent in stall barns.
Milk-handling equipment:		
Milk room, general.....	20	Incandescent or fluorescent.
Washing area.....	100	Sealed fluorescent fixtures, 2-lamp, 40-watt; adjust height above vat, not above tank.
Bulk tank, inside.....	100	Incandescent spots directed at tank interior; portable lamps may be used.

General Indoor Lighting Guide

Area or activity	Recom- mended foot- candles	Typical installation
Feed storage:		
Haymow, silo, grain bins.....	3	Incandescent in protected or dust-proof fixtures.
Feed inspection area, silo room.	20	Incandescent flood.
Concentrate storage, feed processing area.	10	Incandescent flood.
Livestock housing.....	7	Incandescent or fluorescent.
Livestock examination area.....	20	Incandescent spot or flood, or fluorescent.
Stairways and ladders.....	20	Incandescent flood at top and bottom of stairs.
Feeding areas.....	20	Incandescent or fluorescent.
Machinery storage.....	5	Incandescent.
Machinery repair area.....	30	Incandescent or fluorescent with supplemental portable flood.
Farm shop:		
General.....	30	Incandescent or fluorescent: color-corrected mercury if ceiling over 12 feet high.
Bench and machine work, sheet metal, painting.	50	Incandescent flood or fluorescent; adjust height and group lamps as needed.
Machine tool and detailed bench work.	100	Incandescent flood or fluorescent; adjust height and group lamps as needed
Farm office.....	70	Incandescent or fluorescent.
Rest rooms.....	30	Incandescent or fluorescent.
Pump house.....	20	Incandescent.

Use flood- or spot-light fixtures placed so the light will be directed to where it is needed. All outdoor lights attract insects, but yellow, orange, amber, or red lights attract fewer insects. Locate outdoor lamps so that insects attracted by the lamps are not objectionable.

Foot-candle distribution data for flood and spot fixtures can be obtained from power suppliers and fixture manufacturers.

Use the chart on page 12 as a guide for lighting outdoor areas.

PLACEMENT OF FIXTURES

In the farmyard, locate lights so they do not create shadows. Direct the lights away from the vision of travelers on public roads. Light the boundaries of yards and the entrances of driveways to discourage intruders. Use automatic controls to

Lighting Guide for Outdoors

Area or activity	Recommended foot-candles	Typical installation ¹
Protective lighting-----	0. 2	175-w. mercury refractor mounted 25 feet high for lighting 8,000 sq. ft.; or incandescent floodlight. ²
General work areas, driveway, walks, barn lots.	1. 0	400-w. mercury refractor mounted 25 feet high for lighting 8,000 sq. ft.; or incandescent floodlight. ²
Activity areas, fuel storage, building entrance, electrical load center, feedlots and equipment, livestock loading, recreation area.	3. 0	400-w. mercury refractor mounted 25 feet high for 2,000 sq. ft.; or incandescent floodlight or spotlight.

¹ This is based on lumen ratings of clear mercury lamps. Other similar lamps will give increased levels or greater coverage in proportion to total lumen output.

² For multiple lamps, the distance between lamps should not exceed 5 times the mounting height.

turn the lights on and off when you are away.

In buildings, place lighting fixtures where lamps are not likely to be broken or create shadows. Keep lamps out of reach of livestock. Lamps installed in dusty places, such as haylofts and feed rooms, should be in dustproof fixtures.

A light source gives off light in all directions. Reflectors help control light. The proper type of reflector will direct the light where it is needed, help reduce glare, and spread or concentrate light as desired.

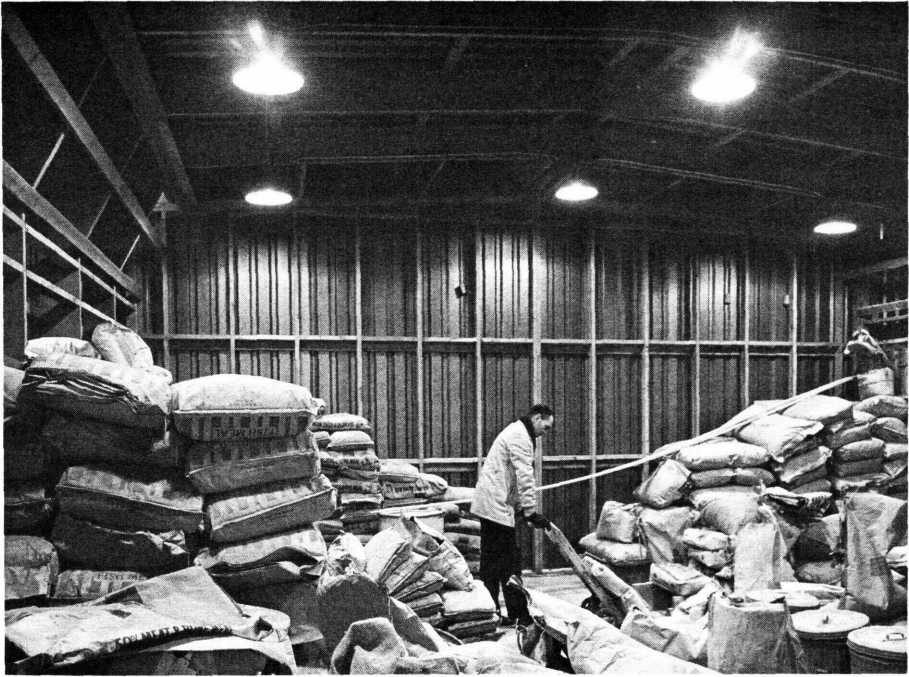
For safety, direct lights downward as much as possible to avoid glare. Outdoors, recess fixtures in curbs or steps or mount them to the

side of the house. Provide convenient switches for all lighting both indoors and outdoors.

Dust and dirt reduce light output. You should regularly dust the lamps, wash the fixtures, clean or repaint walls and ceilings, and replace burned out or blackened lamps.

LIGHT FOR GRADING

The lighting system used for grading agricultural products should provide well diffused light of the correct color and amount. Graders must be able to see fine detail and determine the color of the products they grade.



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Incandescent lamps in standard dome reflectors are a handy and efficient solution to the general lighting of farm buildings.

For grading tobacco, a combination of fluorescent and incandescent lamps have been used in the past. However, fluorescent lamps are now on the market that combine the necessary color qualities in one lamp.

Place the lamps 3 to 4 feet above and 12 inches in from the working side of the grading table. Use two 40-watt fluorescent lamps in industrial-type reflector fixtures placed end to end the length of the work area.

For grading potatoes, apples, and other such produce use fluorescent lamps. Provide at least 50 foot-candles of light for general inspection of produce, 75 to 100 foot-candles for grading, and 150

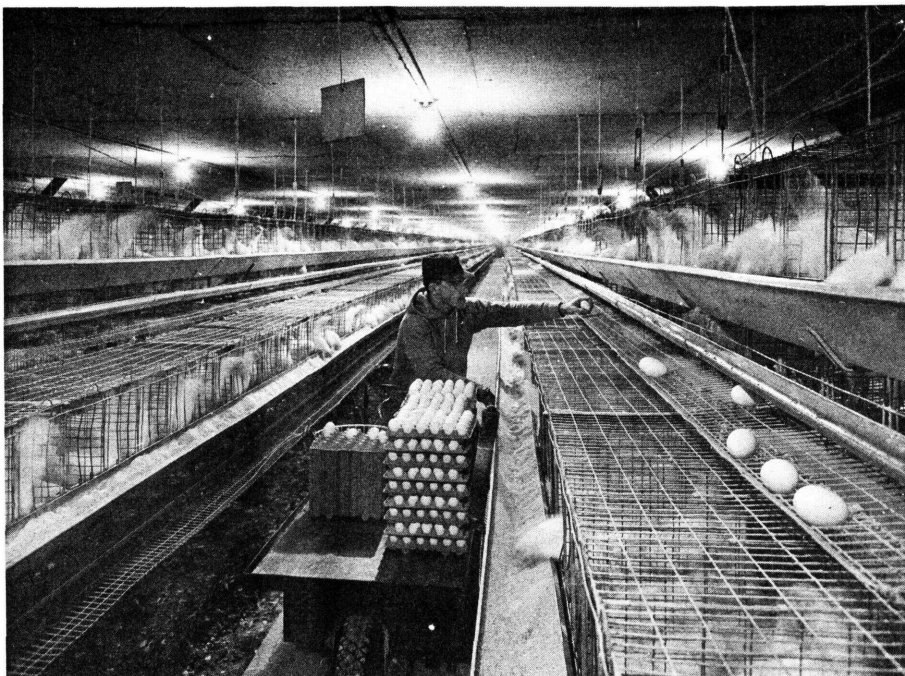
foot-candles for extremely close inspection or grading.

Lighting recommendations for grading different products may vary from one State to another.

INSECT CONTROL

Many insects that fly at night are attracted to light. In general, ultra-violet, blue, and green are much more attractive than yellow, orange, amber, or red. Thus, using yellow lamps in patios, porches, and yards helps reduce nuisance insects.

Fluorescent blacklight lamps produce radiation in the near-ultra-violet region, which is very attractive to many insects. Farm pests



BN-34622

Although the recommended minimum foot-candle levels for poultry buildings are rather low, higher levels of lighting aid farm personnel in maintaining cleanliness and make poultry keeping operations more efficient.

attracted by these lights include European corn borers, corn earworms, tomato and tobacco hornworms, pink bollworms, and cucumber beetles.

Light traps containing these blacklight lamps are used in insect surveys to follow migrations, detect new pests, and monitor population levels so that insecticides may be applied at the proper time.

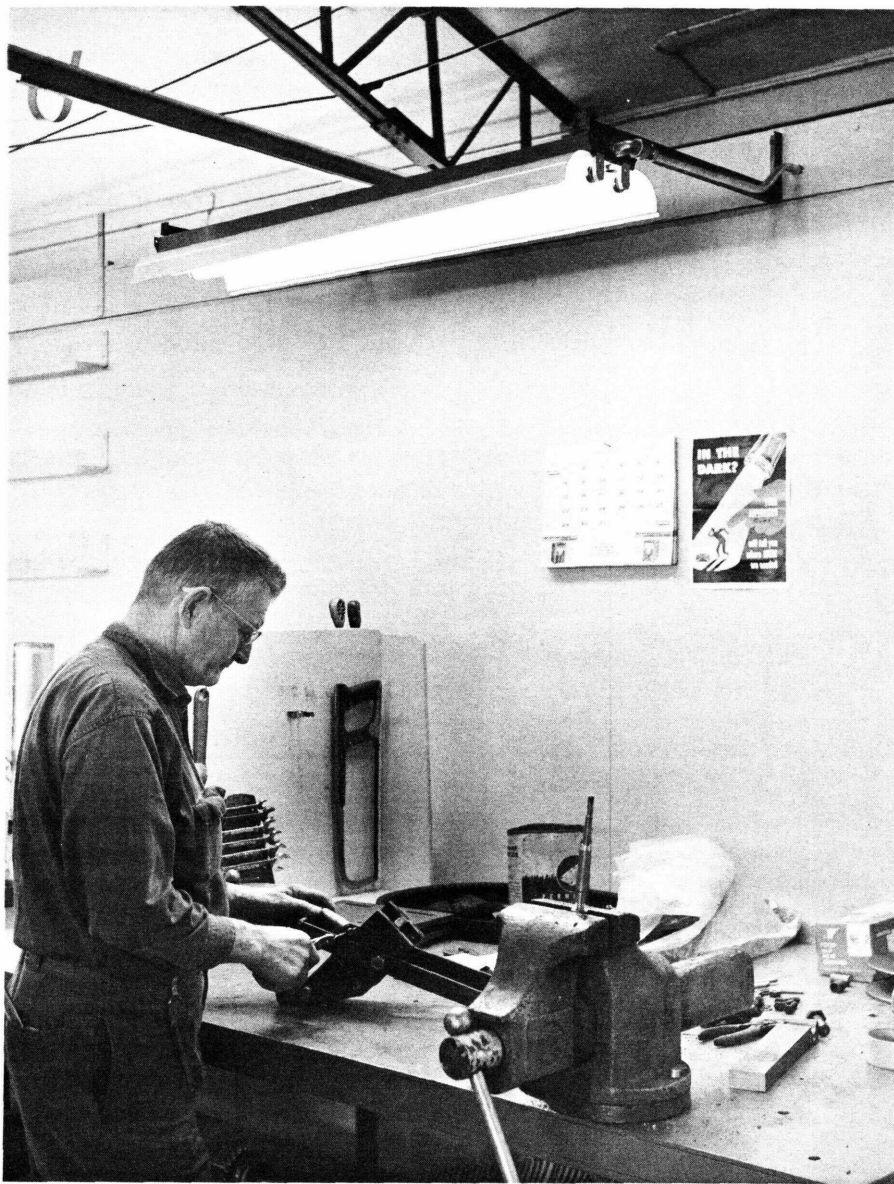
WIRING

Make certain that all wiring complies with the local and national electrical code. All materials used should carry the label of Under-

writers' Laboratories (UL). Low-cost, temporary wiring is not recommended for farm lighting systems. Have all wiring inspected by your local electrical inspector.

Both wiring and fixtures in most farm buildings are often exposed to corrosive fumes and moisture. In buildings that house livestock, use approved moisture-resistant materials such as porcelain-insulated fixtures, galvanized steel or molded plastic junction boxes, and branch circuit cables with a plastic outer covering.

Light switches should be conveniently located on walls. Do not use pull chains; they are inconven-



BN-34621

General workbench lighting with fluorescent fixtures provides illumination over a large area with an absence of strong shadows. Fixtures are best placed over the front edge of the bench.

ient, likely to break, and may be safety hazards. Switches should be installed at all entrances and exits

where lighting must be controlled from more than one point.

Plan for future as well as present

needs. Lighting is only one of several key considerations in determining the total load on a system. Your local electrical contractor or electric power supplier can give you helpful information on the wiring needs of your farm.

Your wiring should allow you to—

- Turn on lights ahead of you as you go from place to place.

- Turn walkway lights on and off from all key work areas.

- Turn on stairway lights before you start up or down the steps.

- Turn lights on and off from each entrance in rooms or areas with two or more entrances.

- Control outdoor flood lights or yard lights from the inside of all frequently used buildings.